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DOPPLER OBSERVATION OF AUBURNDALE WINDSTORM OF AUGUST 12, 1975.(U)
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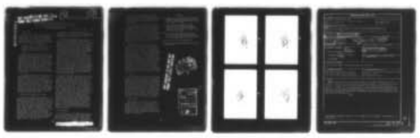

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DOPPLER OBSERVATION OF AUBURNDALE WINDSTORM OF AUGUST 12, 1975

Rosemary M. Dyer, Michael J. Kraus and James F. Morrissey
Air Force Geophysics Laboratory
Hanscom AFB, Massachusetts 01731

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1. INTRODUCTION

The weather pattern for the Boston area the evening of 12 August 1975 was characterized by convective instability, giving rise to scattered thunderstorms. One of these was severe, and it struck sections of Needham, Newton, Waltham, and Wellesley, Massachusetts at approximately 6:45 PM EST. It is described in Storm Data as

> "A sudden electrical storm [which left] in its wake a barn fire, a host of houses struck by lightning, numerous vehicle accidents, power outages and flash flooding ...."

Unmentioned in this account are the straight line winds experienced at the outset of the storm by residents of the Auburndale section of Newton and adjacent areas. Trees up to forty feet tall and three feet in diameter were uprooted, and numerous power lines were down. The effects were confined to a region less than 1.5 square miles in area, and were most dramatic close to the Charles River. Several eye-witnesses commented on the brief lifetime of the phenomenon, and its small extent. People who had ventured less than a mile from home for less than an hour were astonished to find on their return that their street was blocked by fallen trees.

One observer (Stierle, 1975) noted that in uprooting approximately ten trees in a small area along the bank of the river, the wind did not exhibit any organized pattern of damage (that is, rotation). There was no identifiable severe storm signature on conventional radar. In addition, the storm's small extent and brief duration caused it to slip through the Weather Service's network of observers. Consequently, one would look in vain for any trace of this storm in the recorded weather observations of this date. Yet this was a storm that caused extensive power outages, and had the potential for causing fatal injury.

2. DOPPLER VELOCITY PATTERNS ON 12 AUGUST

Alerted by the presence of thunderstorms in the vicinity, the AFGL Weather Radar Branch had its Doppler radar in operation throughout the afternoon and evening of August 12th. The radar was operated in the PPI mode with an elevation angle of 2°, and the output of the pulse-pair processor (Novick and Glover, 1975) was monitored continuously on the color display described by Jagodnik et al., (1975). Every fifteen minutes or so, a complete scan of the storm was made. This was done by lowering the elevation angle to 1° and then increasing the elevation angle one degree after each rotation, and continuing this routine until the top of the storm was reached. Pulse-pair data from this complete scan were recorded to permit a more detailed analysis after the storm had ended.

But, let us confine ourselves to the color display of pulse-pair derived mean velocities, which are available in real time. The pertinent photographs are shown on the next page.

Picture A shows the Doppler color display of a 1° PPI scan taken approximately twenty minutes before the high winds struck Auburndale. The color contours can be converted to Doppler velocity toward or away from the radar by referring to the color code at the right of the display. Contours numbered 51 through 99 (colors green through red) indicate motion away from the radar, and contours 49 through 01 indicate motion toward the radar. The magnitude of, for example, the velocity in the green area between contours 59 and 67 (average 63) is 5.7 m sec^{-1} (11 knots) away from the radar, while that of the pale blue area between contours 41 and 33 (average 37) is of the same magnitude but in the opposite direction. This value agrees well with the winds being recorded at both Logan Airport and the Sudbury radar site at the time Picture A was taken. For a more detailed explanation of the color code used on the velocity display, see Kraus and Donaldson (1976). The important thing to note about Picture A is that the Doppler velocities are all very low and the contours widely spaced. This was characteristic of the other 1° maps being generated throughout the afternoon, and there was no indication whatsoever that any change was imminent.

Picture B shows the 1° scan taken at the time of the windstorm. The range markers are at 16 km intervals (not 8 km, as shown on the display). Note, in particular, the patch of yellow at an azimuth of about 120° approximately 24 km from the radar. This area is directly over Auburndale, and is the only indication on the color display that anything unusual was happening in that region. Also, note that for the first time that day there are three velocity contours packed within a small area. The significance of these observations was not realized until much later. Remember that Picture B is only the first of a sequence of elevation scans through the storm. It was expected that the "interesting" portions of the storm would be observed at the higher elevation angles. Picture C shows the color display for the 2° scan taken less than one minute after Picture B. The yellow patch has disappeared, and once again we observe a fairly homogeneous region of low wind velocities. Fifteen minutes later, the section of higher velocities had disappeared from the 1° scan (Picture D). Its occurrence was soon forgotten by those taking the data and observing it on the color display in real time.

3. SECOND-GUESSING

By 7:30 PM EST, the storm system dissipated, and the radar was turned off. It seemed to all concerned that, once again, a situation that promised severe storms had proved a disappointment. The next day, reports of the damage in Auburndale convinced us that

this case was not another example of the mild thunderstorm situations we had been observing thus far that summer. Indeed, August 12th proved to be the only day during the 1975 summer season on which damaging winds were observed with the Sudbury radar.

The recorded data were played back, and this time the yellow patch was examined in detail. The yellow area on the color display corresponds to an average velocity of 12.8 m sec^{-1} (24 knots) away from the radar. When shown on the video display, Picture B was seen to have a few isolated dots of pink, corresponding to an average velocity of 16.3 m sec^{-1} (31 knots) away from the radar. Neither of these values is likely to cause concern. Thus, it is possible that, even if the yellow patch had been noticed when it first appeared (sometime after 6:24 but no later than 6:45 PM EST), no warning would have been issued.

Undoubtedly, the local winds experienced in the Auburndale area during this storm were far greater than the Doppler velocities recorded at Sudbury. The Doppler radar does not measure the true wind velocity, but only the component along the radar azimuth. The magnitude of this component of the wind depends on the wind direction and the radar viewing angle. If the radar azimuth is very nearly perpendicular to the wind direction, the wind component observed by the radar will be very nearly zero, no matter how strong the wind actually is. We do not know the exact local wind direction in Auburndale at 6:45 PM, but observers on the ground place it roughly in the northwest quadrant. Conceivably, if it had been from the southwest, the Doppler velocity observed by the radar in Sudbury would not even have depicted the area of higher-than-environmental winds. If the Auburndale wind were directly from the north, it's true magnitude would have been double that observed on radar.

4. CONCLUSION

Could a different interpretation of the Doppler velocity pattern shown on the color display, or the display of some derived quantity of the velocity pattern, have permitted warnings of this windstorm to be issued? Our limited experience demonstrates that much more needs to be learned about the interpretation of the Doppler velocity patterns shown on the color display before they can be used to forecast severe straight line winds. It may be that the occurrence of isolated uncharacteristic patches such as that shown in Picture B is a warning that some other (perhaps derived) parameter of the wind field should then be examined. Analysis of digitized data from the Doppler radar is currently being made in hopes of obtaining such a parameter.

5. ACKNOWLEDGMENTS

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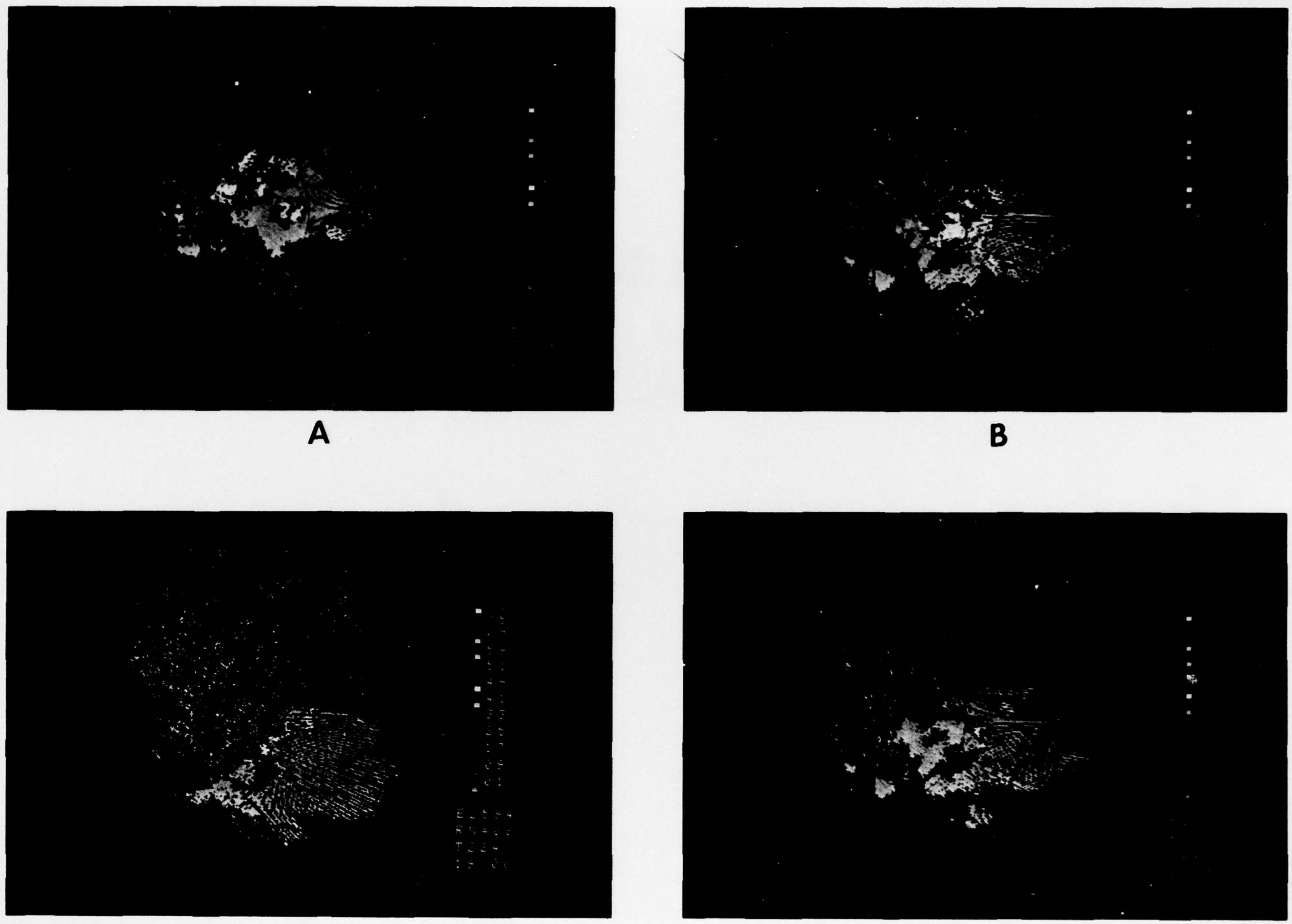

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Rosemary M. Dyer,
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13. ABSTRACT

Contours of pulse-pair mean Doppler velocities displayed on a PPI scope can indicate areas of potentially damaging winds. An illustration of this was the windstorm centered at Auburndale, Massachusetts the evening of August 12, 1975. Areas of high Doppler mean velocity coincided in time with areas of severe straight-line wind damage at the ground. The high winds were apparently confined to within half a kilometer above the surface, and persisted for less than 35 minutes.

KEYWORDS: Doppler radar, Severe weather, Forecasting, Color display, Windstorm

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